CLAIMS

1. A fuel cell gas separator comprising a first layer which is formed of a material that is impermeable to gases, a second layer which is formed of a material that is impermeable to gases, the first and second layers having perforations through their thickness which are closed by electrically conductive plug material, and a third intermediate layer between the first and second layers which is electrically conductive and is in electrical contact with the plug material in the perforations through the first and second layers.

2. A gas separator according to claim 1 wherein the materials of the first and second layers are the same.

3. A gas separator according to claim 1 or claim 2 wherein the material of each of the first and second layers is zirconia.

4. A gas separator according to claim 3 wherein the zirconia is yttria-stabilised.

5. A gas separator according to claim 3 wherein the zirconia contains up to about 20 wt.% alumina.

6. A gas separator according to any one of claims 1 to 5 wherein the thickness of each of the first and second layers is in the range 20 to 250 μm.

7. A gas separator according to any one of claims 1 to 6 wherein the thickness of the third intermediate layer is in the range 10 to 100 μm.

8. A gas separator according to any one of claims 1 to 7 wherein the electrically conductive material of the third intermediate layer is selected from cobaltite, Ag, Au, Pt, Ni, alloys containing one or more of said metals, and other silver-based materials.

AMENDED CLAIMS
[received by the International Bureau on 15 May 2003 (15.05.03); claim 11 amended, remaining claims unchanged (1 page)]

9. A gas separator according to any one of claims 1 to 8 wherein the material of the third intermediate layer is the same as the electrically conductive plug material.

10. A gas separator according to any one of claims 1 to 9 wherein the perforations extend perpendicularly through the thickness of the first and second layers.

11. A gas separator according to any one of claims 1 to 10 wherein the perforations in the first layer are offset relative to the perforations in the second layer.

12. A gas separator according to any one of claims 1 to 11 wherein each perforation has an average cross-sectional dimension in the range of 50 to 1000μm.

13. A gas separator according to any one of claims 1 to 12 wherein the total area of the perforations through each of the first and second layers is in the range of 0.1 to 20 mm^2 per 1000 mm^2 surface area of an electrode-contacting zone of said layer.

14. A gas separator according to any one of claims 1 to 13 wherein the electrically conductive plug material is selected from cobaltite, Ag, Au, Pt, Ni, alloys containing one or more of said metals, and other silver-based materials.

15. A gas separator according to claim 14 wherein the electrically conductive plug material is selected from metallic silver, a metallic mixture in which Ag is the major component, a silver alloy and a silver-glass composite.

16. A gas separator according to claim 15 wherein the electrically conductive plug material is silver alloyed or mixed with any one or more of gold, palladium, platinum and stainless steel.

17. A gas separator according to claim 15 wherein the electrically conductive plug material is a silver-glass composite containing from about 10 to about 40 wt% glass.

18. A gas separator according to claim 17 wherein the silver-glass composite contains from about 15 to 30 wt% glass.

19. A gas separator according to any one of claims 15, 17 and 18 wherein the silver in the silver-glass composite is selected from commercially pure silver and a silver alloy or mixture.

20. A gas separator according to claim 19 wherein the silver is alloyed or mixed with any one or more of gold, palladium, platinum and stainless steel.

21. A gas separator according to any one of claims 15 and 17 to 20 wherein the glass in the silver-glass composite is stable against crystallization.

22. A gas separator according to any one of claims 15 and 17 to 21 wherein the glass in the silver-glass composite is a high silica glass.

23. A gas separator according to claim 22 wherein the composition of the glass is 0-5.5 wt% Na_2O, 8-14 wt% K_2O, 0-2.2 wt% MgO, 1-3 wt% CaO, 0-6 wt% SrO, 0-8 wt% BaO, 6-20 wt% B_2O_3, 3-7 wt% Al_2O_3, 58-76 wt% SiO_2 and 0-10 wt% ZrO_2.

24. A gas separator according to claim 23 wherein the composition of the glass is 0-2.0 wt% Na_2O, 8-13.5 wt% K_2O, 0-0.05 wt% MgO, 1-1.6 wt% CaO, 0.5-1 wt% SrO, 0-4.4 wt% BaO, 6-20 wt% B_2O_3, 3-6.0 wt% Al_2O_3, 60-75 wt% SiO_2 and 0-5.0 wt% ZrO_2.

25. A gas separator according to any one of claims 1 to 24 wherein a respective electrically conductive coating is provided on the electrically conductive plug material at the electrode-facing side of each of the first and second layers.

26. A gas separator according to claim 25 wherein each of said coatings extends over a respective electrode-contacting zone of each of the first and second layers.

27. A gas separator according to claim 25 or claim 26 wherein the electrically conductive coating on a cathode-facing side is of Ag or Ag alloy.

28. A gas separator according to claim 27 wherein the coating on the cathode-facing side is Ag-Sn alloy that contains from about 4 to about 20 wt% Sn.

29. A gas separator according to claim 27 or 28 wherein the coating on the cathode-facing side is Ag-Sn alloy that includes up to 10 wt% of dopants to improve the electrical conductivity of said coating.

30. A gas separator according to any one of claims 27 to 29 wherein the coating on the cathode-facing side is Ag-Sn alloy and has a thickness in the range of 10 to 1000 μm.

31. A gas separator according to any one of claims 27 to 30 wherein the coating on the cathode-facing side is Ag-Sn alloy having a surface layer of SnO_2.

32. A gas separator according to claim 27 wherein the coating on the cathode-facing side is of commercially pure silver and has a thickness in the range of 50 to 250 μm.

33. A gas separator according to any one of claims 25 to 32 wherein the electrically conductive coating on an anode-facing side is of commercially pure nickel.

34. A gas separator according to claim 33 wherein the nickel coating on the anode-facing side is commercially pure.

35. A gas separator according to claim 33 or 34 wherein the layer of nickel on the anode-facing side has a thickness in the range of 10 to 1000μm.

36. A gas separator according to any one of claims 33 to 35 wherein a layer of silver is disposed on the electrode-contacting zone between the coating of nickel and the anode-facing side of the respective first or second layer.

37. A gas separator according to claim 36 wherein the layer of silver comprises commercially pure silver.

38. A gas separator according to claim 36 or claim 37 wherein the layer of silver has a thickness in the range of 10 to 1000μm.

39. A gas separator according to any one of claims 1 to 38 wherein surface formations defining gas flow passages therebetween are provided on an electrode-facing side of each of the first and second layers, said surface formations being electrically conductive and overlying the perforations containing the electrically conductive plug material.

40. A gas separator according to claim 39 wherein the surface formations on an anode-facing side are formed of solid oxide fuel cell anode material and the surface formations on a cathode-facing side are formed of solid oxide fuel cell cathode material, said surface formations being bonded to the first and second layers or to any electrically conductive coating thereon.

41. A gas separator according to claim 39 or claim 40 wherein a respective electrically conductive coating is provided over the surface formations on the anode-facing side and on the cathode-facing side.

42. A gas separator according to claim 41 wherein the coating on the surface formations on the cathode-facing side is of metallic silver.

43. A gas separator according to claim 41 or claim 42 wherein the coating on the surface formations on the anode-facing side is of nickel.

44. A method of forming a fuel cell gas separator which comprises:

providing first and second layers of the gas separator, said first and second layers being formed of material that is impermeable to gases and having perforations through their thickness;

superposing the first and second layers with a third layer of electrically conductive material having a first thickness interposed between the first and second layers;

compressing the superposed first, second and third layers under conditions which cause the electrically conductive material to flow to produce a gas separator in which the third layer of electrically conductive material has a second thickness less than the first thickness and said electrically conductive material has flowed into the perforations in the first and second layers to plug said perforations.

45. A method according to claim 44 wherein the first and second layers are formed or oriented such that the perforations through said first and second layers are not coincident.